TITLE OF THE INVENTION

Resin Sealing Apparatus and Resin Sealing Method

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a resin sealing (or encapsulating) apparatus and a resin sealing (or encapsulating) method for forming an electronic component by sealing a chip-like element (hereinafter properly referred to as "chip") mounted on a circuit board (hereinafter referred to as "substrate") such as a printed board with resin.

Description of the Background Art

A conventional resin sealing apparatus is described with reference to Figs. 7 to 10. All drawings described below are exaggeratedly illustrated for simplifying the description.

As shown in Figs. 7 to 10, the conventional resin sealing apparatus is provided with a resin sealing mold 3 having a lower mold section 1 and an upper mold section 2. The lower mold section 1 is provided with a recess 4. A substrate block 5 partially constituting the lower mold section 1 is set in the recess 4. A disc (conical) spring unit 7 formed by a plurality of disc springs 6 elastically supports the substrate block 5. A spacer 8 having a prescribed thickness is provided between the disc spring unit 7 and the bottom surface of the recess 4. A pot block 9 is fixed to the recess 4 to be adjacent to the substrate block 5. In other words, the disc spring unit 7 elastically supports the substrate block 5 to be vertically movable in contact with the side walls of the pot block 9. The pot block 9 is provided with a pot portion 10 having a cylindrical space. A columnar plunger 11 is provided in the pot portion 10 to be vertically movable. A resin tablet 12 is set on the plunger 11 as a raw material for fluid resin.

The upper mold section 2 is provided with a concave cull 13 on a position opposite to the pot portion 10. A trench-shaped runner 14 is provided to be continuous to the cull 13. Further, a cavity 15 is provided to be continuous to the runner 14. When the upper and lower mold sections 2 and 1 are closed, the pot

portion 10 and the cavity 15 communicate with each other through a resin passage formed by the cull 13 and the runner 14. A substrate 16 mounted with one or a plurality of chips (not shown) is set on the substrate block 5 so that end surfaces (right side surfaces in Figs. 7 to 10) of the substrate 16 and the substrate block 5 are flush with each other. The substrate 16 is so set on the substrate block 5 that the cavity 15 stores the chip(s) mounted thereon when the upper and lower mold sections 2 and 1 are closed.

The aforementioned conventional resin sealing apparatus operates as follows: First, the upper mold section 2 moves downward in the state shown in Fig. 7. Thus, the lower surface of the upper mold section 2 comes into contact with the upper surface of the pot block 9 provided on the lower mold section 1 on a die matching plane P.L., so that the upper and lower sections 2 and 1 are closed. In this mold closing state of the upper and lower mold sections 2 and 1, the substrate block 5 elastically supported by the disc spring unit 7 and the upper mold section 2 hold the substrate 16 therebetween with a prescribed clamp pressure. The pot block 9 is pressed against the upper mold section 2.

When the upper and lower mold sections 2 and 1 are closed, the substrate block 5 moves downward in contact with the side walls of the pot block 9. Then, a heater (not shown) provided on the lower mold section 1 heats the resin tablet 12 as shown in Fig. 8, thereby melting the same. Consequently, fluid resin 17 is formed.

Then, the plunger 11 moves upward. Thus, the fluid resin 17 is injected into the cavity 15 subsequently through the cull and the runner 14 due to the pressure applied from the plunger 15, as shown in Fig. 8. Then, the fluid resin 17 is further heated and thereby hardened. Consequently, hardened resin is formed. Thus, a resin molding including the substrate 16, the chip(s) and the hardened resin is completed. Thereafter the upper and lower mold sections 2 and 1 are so opened that the resin molding including the substrate 16 and the hardened resin is taken out. When the upper and lower mold sections 2 and 1 are opened, the substrate block 5 moves upward

in contact with the side walls of the pot block 9.

However, the aforementioned prior art has the following problems:

The first problem arises from a clearance formed between the end surface (right side surface in Fig. 9) of the substrate 16 and a side wall (left side surface in Fig. 9) of the pot block 9 as shown in Fig. 9. In the conventional resin sealing apparatus, a clearance 18 is provided between the side walls of the substrate block 5 and the pot block 9 for protecting the vertical moving function of the substrate block 5. Therefore, the fluid resin 18 partially infiltrates into the clearance 18 and is thereafter hardened. Thus, unnecessary hardened resin 19 is formed in the clearance 18, as shown in Fig. 9. In this case, the unnecessary hardened resin 19 is held between the substrate block 5 and the pot block 9 or adheres to the substrate block 5 in the clearance 18. In a subsequent resin sealing step, therefore, the hardened resin 19 inhibits the substrate block 5 from vertical movement. Thus, the upper and lower mold sections 2 and 1 are so insufficiently closed that another clearance 20 is formed between the upper surface of the pot block 9 and the lower surface of the upper mold section 2 as shown in Fig. 10. The fluid resin 17 partially flows into this clearance 20 and is hardened to form a resin burr. Consequently, the resin molding is rendered defective. Further, the aforementioned resin burr inhibits the substrate block 5 from downward movement. Therefore, the upper mold section 2 pushes down the substrate 16 with an excessive clamp pressure. Consequently, the substrate 16 may be damaged or broken depending on the characteristics thereof.

The second problem arises from the elastic force of the disc spring unit 7 employed for holding the substrate 16. If having a relatively large thickness, the substrate 16 may be damaged when pressed against the upper mold section 2 with an excessive clamp pressure. Also in this case, the clearance 20 is formed between the upper surface of the pot block 9 and the lower surface of the upper mold section 2, and a resin burr may be formed in this clearance 20 to result in a defective resin molding. When the substrate 16 is exchanged for another substrate 16 having a different thickness,

the disc spring unit 7 suitable for the precedent substrate 16 may be incapable of absorbing the difference between the thicknesses of the two types of substrates 16. In this case, the number of the disc springs 6 must be increased or decreased by decomposing the lower mold section 1 or the spacer 8 must be exchanged for another one having a different thickness. Consequently, the number of manufacturing steps is disadvantageously increased. This problem may also arise when the disc spring unit 7 is replaced with another type of spring or another elastic member of a polymeric material or the like for holding the substrate 16 with a proper clamp pressure.

Among the aforementioned problems, that related to the unnecessary hardened resin 19, i.e. a resin burr, can easily arise as fluid resin having low viscosity is widely used in order to reduce the thickness of an electronic component.

SUMMARY OF THE INVENTION

The present invention has been proposed in consideration of the aforementioned problems, and an object thereof is to provide a resin sealing apparatus and a resin sealing method preventing formation of a resin burr, damage of a resin molding and additional labor for adjusting the height of the resin molding.

In order to attain the aforementioned object, a resin sealing apparatus according to a first aspect of the present invention comprises a lower mold section receiving a substrate mounted with a chip-like element. A pot block is fitted in the lower mold section to be vertically movable. The pot block has a pot portion reserving fluid resin. A plunger is fitted in the pot portion to be vertically movable. The plunger extrudes the fluid resin. An upper mold section is provided oppositely to the lower mold section. The upper mold section has a cavity storing the chip-like element and a resin passage rendering the pot portion and the cavity communicate with each other. This resin sealing apparatus seals the chip-like element with hardened resin formed by the fluid resin injected into and hardened in the cavity.

This resin sealing apparatus further comprises vertical moving means vertically moving the pot block. When the upper and lower mold sections are closed, the upper

and lower mold sections hold the substrate therebetween with a proper pressure while the vertical moving means presses the pot block against the upper mold section. When the upper and lower mold sections are released from mold closing, on the other hand, the vertical moving means moves the pot block upward in contact with the lower mold section.

A resin sealing apparatus according to a second aspect of the present invention comprises a lower mold section receiving a substrate mounted with a chip-like element. A pot block is fitted in the lower mold section. The pot block has a pot portion reserving fluid resin. A vertically movable plunger is fitted in the pot portion. The plunger extrudes the fluid resin. An upper mold section is provided oppositely to the lower mold section. The upper mold section has a cavity storing the chip-like element and a resin passage rendering the pot portion and the cavity communicate with each other. This resin sealing apparatus seals the chip-like element with hardened resin formed by the fluid resin injected into and hardened in the cavity.

This resin sealing apparatus further comprises a movable member pressing the substrate against the side wall of the pot block before the upper and lower mold sections are completely closed. This resin sealing apparatus having the pot block and the lower mold section which are relatively vertically movable injects the fluid resin into the cavity while pressing the substrate against the side wall of the pot block.

A resin sealing method according to the first aspect of the present invention employs a resin sealing apparatus comprising a lower mold section receiving a substrate mounted with a chip-like element. A pot block is fitted in the lower mold section to be vertically movable. The pot block has a pot portion reserving fluid resin. A plunger is fitted in the pot portion to be vertically movable. The plunger extrudes the fluid resin. An upper mold section is provided oppositely to the lower mold section. The upper mold section has a cavity storing the chip-like element and a resin passage rendering the pot portion and the cavity communicate with each other.

The resin sealing method according to the first aspect of the present invention

uses the aforementioned resin sealing apparatus for sealing the chip-like element with hardened resin formed by the fluid resin injected into and hardened in the cavity.

In this resin sealing method, the upper and lower mold sections hold the substrate therebetween with a proper pressure. Then, the pot block is pressed against the upper mold section. The upper and lower mold sections are closed through the aforementioned steps of holding the substrate and pressing the pot block. In the aforementioned resin sealing method, the fluid resin is injected into the cavity with the plunger, and thereafter hardened. Then, the pot block is moved upward in contact with the lower mold section after the upper and lower mold sections are released from mold closing.

A resin sealing method according to the second aspect of the present invention employs a resin sealing apparatus comprising a lower mold section receiving a substrate mounted with a chip-like element. A pot block is fitted in the lower mold section to be vertically movable. The pot block has a pot portion reserving fluid resin. A plunger is fitted in the pot portion to be vertically movable. The plunger extrudes the fluid resin. An upper mold section is provided oppositely to the lower mold section. The upper mold section has a cavity storing the chip-like element and a resin passage rendering the pot portion and the cavity communicate with each other.

The resin sealing method according to the second aspect of the present invention uses the aforementioned resin sealing apparatus for sealing the chip-like element with hardened resin formed by the fluid resin injected into and hardened in the cavity.

In this resin sealing method, the upper and lower mold sections hold the substrate therebetween. Then, the pot block is pressed against the upper mold section. The upper and lower mold sections are closed through the steps of holding the substrate and pressing the pot block. In the aforementioned resin sealing method, the substrate is pressed against the side wall of the pot block before the upper and lower mold sections are completely closed, so that the fluid resin is injected into the cavity with the plunger and thereafter hardened in this state. Then, the upper and lower mold sections

are opened.

In the resin sealing apparatus and the resin sealing method according to the first aspect of the present invention, the pot block is moved upward in contact with the lower mold section when the upper and lower mold sections are released from mold closing. Also when unnecessary hardened resin is formed by part of the fluid resin infiltrating into a clearance, therefore, the unnecessary hardened resin is expelled due to the upward movement of the pot block. Therefore, smooth sliding is ensured between the lower mold section and the pot block. Thus, formation of a clearance between the upper surface of the pot block and the lower surface of the upper mold section as well as formation of a resin burr in such a clearance are prevented. Further, the substrate is prevented from damage.

In addition, the upper and lower mold sections hold the substrate therebetween with a proper clamp pressure without through a disc spring unit. Thus, the resin sealing apparatus holds the substrate with a proper clamp pressure by controlling the operation of the upper or lower mold section as compared with a case of holding the substrate through elasticity of a disc spring unit. Also when the substrate is dispersed in thickness and variable in standard, therefore, the substrate is prevented from damage and the vertical position thereof may not be adjusted through disc springs or a spacer.

When the upper and lower mold sections are closed, the vertical moving means presses the pot block against the upper mold section. Thus, formation of a clearance between the upper surface of the pot block and the lower surface of the upper mold section as well as formation of a resin burr in such a clearance are prevented.

In the resin sealing apparatus and the resin sealing method according to the second aspect of the present invention, the fluid resin is injected into the cavity when the upper and lower mold sections are closed and the substrate is pressed against the side wall of the pot block with formation of no clearance between the side wall of the pot block and the end surface of the substrate. Thus, the fluid resin is prevented from infiltrating into a clearance provided between the lower mold section and the pot block.

Thus, no unnecessary hardened resin is formed in such a clearance, whereby smooth sliding is ensured between the lower mold section and the pot block. Thus, formation of a resin burr in a clearance between the upper surface of the pot block and the lower surface of the upper mold section as well as damage of the substrate are prevented.

The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view showing a resin sealing apparatus according to a first embodiment of the present invention in a state immediately before mold closing;

Fig. 2 is a sectional view showing the resin sealing apparatus according to the first embodiment in a state injecting fluid resin into a cavity after mold closing;

Fig. 3 is a sectional view showing a resin sealing apparatus according to a second embodiment of the present invention in a state immediately after a substrate comes into contact with a pot block before mold closing;

Fig. 4 is a sectional view showing the resin sealing apparatus according to the second embodiment in a state injecting fluid resin into a cavity after mold closing;

Fig. 5 is a sectional view showing a resin sealing apparatus according to a third embodiment of the present invention in a state injecting fluid resin into a cavity after a substrate comes into contact with a pot block upon mold closing;

Fig. 6 is a sectional view showing the resin sealing apparatus according to the third embodiment in an opened state;

Fig. 7 is a sectional view showing a conventional resin sealing apparatus in a state immediately before mold closing;

Fig. 8 is a sectional view showing the conventional resin sealing apparatus in a state injecting fluid resin into a cavity after mold closing;

Fig. 9 is a sectional view showing the conventional resin sealing apparatus with fluid resin infiltrating into a clearance; and

Fig. 10 is a sectional view showing the fluid resin, infiltrating into the clearance, hardened to inhibit a substrate block from vertical movement.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Resin sealing apparatuses according to embodiments of the present invention are now described with reference to Figs. 1 to 6. The resin sealing apparatus according to each embodiment of the present invention is substantially similar in basic structure to the conventional resin sealing apparatus. In the conventional resin sealing apparatus shown in Figs. 7 to 10 and the resin sealing apparatuses according to the embodiments shown in Figs. 1 to 6, portions having similar structures and functions are denoted by the same reference numerals respectively.

(First Embodiment)

A resin sealing apparatus according to a first embodiment of the present invention is described with reference to Figs. 1 and 2. In the resin sealing apparatus according to the first embodiment, a lower mold section 1 is provided with a recess 4, as shown in Fig. 1. A substrate block 5 partially constituting the lower mold section 1 is provided in the recess 4 to be in contact with the bottom surface thereof. In other words, the substrate block 5 is provided to be in direct contact with the recess 4 of the lower mold section 1 without through an elastic member such as a disc spring unit. According to the first embodiment, a coil spring 21 supported on the lower mold section 1 elastically supports a pot block 9. More specifically, the coil spring 21 is fitted in a fitting hole 22 provided on the lower surface of the pot block 9 and another fitting hole 23 provided on a position of the lower mold section 1 up to a prescribed depth from the bottom surface of the recess 4 oppositely to the fitting hole 22 respectively.

Operations of the resin sealing apparatus according to the first embodiment are now described. When an upper mold section 2 and the lower mold section 1 are opened, the upper surface of the pot block 9 projects from the upper surface of a substrate 16, as shown in Fig. 1.

Then, the mold surface of the upper mold section 2 subsequently comes into

contact with the upper surfaces of the pot block 9 and the substrate 16. Thus, the upper mold section 2 is pressed against the pot block 9 and the substrate 16 respectively with a prescribed clamp pressure, as shown in Fig. 2. Therefore, the coil spring 21 is contracted due to the downward movement of the pot block 9, and the upper and lower mold sections 2 and 1 are closed. Then, fluid resin 17 is injected into a cavity 15 and thereafter hardened. Consequently, hardened resin (not shown) is formed.

According to the first embodiment, the clamp pressure for pressing the upper mold section 2 against the pot block 9 and the substrate 16 is previously set to satisfy the following two conditions:

First, the clamp pressure is set to a value not damaging the substrate 16 in response to the characteristics thereof. This clamp pressure can be changed by controlling the operation of the lower mold section 1 or the upper mold section 2. In other words, the clamp pressure is adjusted by a pressure sensor detecting the value thereof and control means controlling vertical movement of the upper mold section 2 or the lower mold section 1 (the upper mold section 2 in Fig. 1) on the basis of the value detected by the pressure sensor.

Second, the clamp pressure is set to a sufficiently large value so that the sum of the clamp pressure and a pressure applied to the upper mold section 2 from the pot block 9 through the coil spring 21 causes no clearance (refer to the clearance 20 shown in Fig. 10) between the pot block 9 and the upper mold section 2, i.e., no leakage of the fluid resin 17. The upper mold section 2 and the substrate block 5 set on the lower mold section 1 without through an elastic member hold the substrate 16 therebetween. In this step, therefore, the upper mold section 2 directly applies a proper clamp pressure responsive to the characteristics of the substrate 16 to the substrate 16, thereby preventing the substrate 16 from damage. Further, the pot block 9 and the upper mold section 2 are prevented from formation of a clearance therebetween, whereby formation of a resin burr is also prevented. Therefore, a resin molding is prevented from a failure.

Then, the upper mold section 2 moves upward so that the upper and lower

mold sections 2 and 1 are opened. When the upper mold section 2 starts to move upward, i.e., when the upper and lower mold sections 2 and 1 are released from mold closing, the pot block 9 is thrust up due to extension of the coil spring 21, to return to the position shown in Fig. 1. Following this, the pot block 9 moves upward in contact with the substrate block 5. Also when part of the fluid resin 17 infiltrating into a clearance 18 between the pot block 9 and the substrate block 5 is hardened to form unnecessary hardened resin (refer to the unnecessary hardened resin 19 shown in Fig. 10), therefore, the upwardly moving pot block 9 expels the unnecessary hardened resin. Therefore, the function of the pot block 9 for smooth vertical movement is not damaged. Then, an ejection pin (not shown) provided on the lower mold section 1 ejects the resin molding from the lower mold section 1, so that a transport mechanism (not shown) thereafter delivers the resin molding.

In the resin sealing apparatus according to the first embodiment, the unnecessary hardened resin formed in the clearance 18 between the pot block 9 and the substrate block 5 is expelled due to the upward movement of the pot block 9. Therefore, smooth sliding is ensured between the substrate block 5 of the lower mold section 1 and the pot block 9. Further, the pot block 9 is pressed against the upper mold section 2 with a proper pressure when the upper and lower mold sections 2 and 1 are closed. Therefore, formation of a clearance between the upper surface of the pot block 9 and the lower surface of the upper mold section 2 as well as formation of a resin burr in such a clearance are prevented. When the upper and lower mold sections 2 and 1 are closed, further, the upper and lower mold sections 2 and 1 hold the substrate 16 therebetween with a proper clamp pressure. Therefore, the substrate 16 is prevented from damage, and the vertical position of the substrate 16 may not be adjusted with disc springs or a spacer (refer to the disc springs 6 and the spacer 8 shown in Figs. 7 to 10) also when the substrate 16 is dispersed in thickness and variable in standard.

According to the first embodiment, the coil spring 21 employed as an elastic member functions as vertical moving means for vertically moving the pot block 9.

When the upper and lower mold sections 2 and 1 are closed, the upper mold section 2 presses the pot block 9, thereby contracting the coil spring 21 for moving the pot block 9 downward. When the upper and lower mold sections 2 and 1 are opened, on the other hand, the coil spring 21 extends to move the pot block 9 upward.

(Second Embodiment)

A resin sealing apparatus according to a second embodiment of the present invention is described with reference to Figs. 3 and 4. As shown in Figs. 3 and 4, the resin sealing apparatus according to the second embodiment presses a substrate 16 against a pot block 9 when injecting fluid resin 17 into a cavity 15, in addition to operations similar to those of the resin sealing apparatus according to the first embodiment. More specifically, a movable member, i.e., a pin 24 capable of horizontally moving forward and backward is provided on an upper mold section 2. A trench 25 having a width corresponding to the operating range of the pin 24 is provided on a position of a lower mold section 1 opposite to the pin 24. When the upper and lower mold sections 2 and 1 are closed, therefore, the trench 25 stores the pin 24.

The resin sealing apparatus according to the second embodiment operates as follows: First, the pin 24 presses the substrate 16 against the pot block 9 along arrow shown in Fig. 3 with proper force before the upper and lower mold sections 2 and 1 are completely closed. Then, the upper mold section 2 moves downward so that the upper and lower mold sections 2 and 1 are closed. In this process, the pin 24 and the pot block 9 move downward in contact with the substrate 16 respectively.

As shown in Fig. 3, the upper and lower mold sections 2 and 1 are closed so that the fluid resin 17 is injected into the cavity 15 and thereafter hardened while the pin 24 presses the substrate 16 against the pot block 9 with a proper pressure. In this step, the substrate 16 is so pressed against the pot block 9 as to prevent formation of a clearance between an end surface (right side in Figs. 3 and 4) of the substrate 16 and a side wall of the pot block 9. Therefore, no fluid resin 17 infiltrates into a clearance 18 formed between the side walls of a substrate block 5 and the pot block 9.

Consequently, the clearance 18 is prevented from formation of unnecessary hardened resin (refer to the unnecessary hardened resin 19 shown in Fig. 10).

As hereinabove described, the resin sealing apparatus according to the second embodiment attains the following effect in addition to those attained by the resin sealing apparatus according to the first embodiment: The clearance 18 formed between the substrate block 5 and the pot block 9 is prevented from formation of unnecessary hardened resin. Therefore, smooth sliding is ensured between the lower mold section 1 and the pot block 9.

In the aforementioned resin sealing apparatus, the pin 24 for pressing the substrate 16 against the pot block 9 is provided on the upper mold section 2. However, the present invention is not restricted to the aforementioned structure but the pin 24 may alternatively be provided on the lower mold section 1. Further alternatively, the pin 24 may be provided on a side of the lower mold section 1 independently of the upper and lower mold sections 2 and 1. In any one of the aforementioned structures, further, the pin 24 may move forward to press the substrate 16 against the pot block 9 before the upper and lower mold sections 2 and 1 are closed and may move backward to separate from the pot block 9 after the upper and lower mold sections 2 and 1 are closed. In addition, the pin 24 may continuously press the substrate 16 against the pot block 9 when the upper and lower mold sections 2 and 1 are closed.

In the resin sealing apparatus according to the second embodiment, further, the substrate block 5 is directly in contact with the bottom surface of a recess 4 of the lower mold section 1. However, the present invention is not restricted to this but the pin 24 may press the substrate 16 against the pot block 9 while an elastic member (refer to the disc spring unit 7 shown in Figs. 7 to 10) elastically supports the substrate block 5. Also according to this structure, the clearance 18 between the substrate block 5 and the pot block 9 is prevented from formation of unnecessary hardened resin, whereby smooth sliding is ensured between the substrate block 5 and the pot block 9. Further, the pot block 9 may be directly set on the bottom surface of the recess 4, while some elastic

member may elastically support the substrate block 5. Also according to this structure, the clearance 18 is prevented from formation of unnecessary hardened resin, whereby smooth sliding is ensured between the substrate block 5 and the pot block 9. In any one of the aforementioned structures, another type of spring such as a spring of a metallic material, a composite material containing a metal or a polymeric material may be used as the elastic member.

(Third Embodiment)

A resin sealing apparatus according to a third embodiment of the present invention is now described with reference to Figs. 5 and 6. In the resin sealing apparatus according to the third embodiment, a thrust bar 26 provided as vertical moving means different from a coil spring 21 operates after an upper mold section 2 and a lower mold section 1 are released from mold closing, as shown in Figs. 5 and 6. The thrust bar 26, formed by a cylindrical member or a plurality of platelike members, is provided outside a holding member 27 holding the shaft of a plunger 11. This thrust bar 26 is connected to driving means (not shown) having proper thrust force, and vertically moved by this driving means. A pot block 9 thrust by the thrust bar 26 moves upward beyond a position reached when the same is pressed by the coil spring 21 in a completely extending state.

The resin sealing apparatus according to the third embodiment operates as follows: When the upper and lower mold sections 2 and 1 are opened, the thrust bar 26 stands by on an initial position at an interval from the pot block 9.

As shown in Fig. 5, the upper mold section 2 moves downward so that the upper and lower mold sections 2 and 1 are closed similarly to the structure shown in Fig. 2. In this state, the coil spring 21 presses the pot block 9 against the upper mold section 2 with proper force. Similarly to the resin sealing apparatus according to the second embodiment, a pin 24 presses a substrate 16 against the pot block 9 with proper force before the upper and lower mold sections 2 and 1 are completely closed. The pin 24, operating similarly to that in the second embodiment following this step, may not be

provided in the present invention.

Then, fluid resin 17 is injected into a cavity 15 and thereafter hardened, thereby completing a resin molding 29 including the substrate 16 and hardened resin 28. Then, the upper mold section 2 moves upward. In the resin sealing apparatus according to the third embodiment, the coil spring 21 extends to relatively thrust the pot block 9 upward with respect to the lower mold section 1 when the upper mold section 2 starts to move upward, i.e., when the upper and lower mold sections 2 and 1 are released from mold closing, so that the pot block 9 returns to the initial position (see Fig. 1). Following this step, an ejection pin 30 provided on the lower mold section 1 thrusts the resin molding 29 upward from the lower mold section 1 (substrate block 5) along with the upward movement of the pot block 9. Further, another ejection pin (not shown) provided on the upper mold section 2 thrusts the resin molding 29 downward from the upper mold section 2.

As shown in Fig. 6, the thrust bar 26 moves upward to further thrust the pot block 9. Thereafter a transport mechanism (not shown) delivers the resin molding 29 thrust from the lower mold section 1 by the ejection pin 30.

In the resin sealing apparatus according to the third embodiment, the thrust bar 26 moves the pot block 9 upward to a position above the position reachable through extension of the coil spring 21. Also when unnecessary hardened resin is formed in a lower portion of a clearance 18 between the pot block 9 and the substrate block 5, therefore, the thrust bar 26 moves the pot block 9 upward thereby expelling the unnecessary hardened resin. Further, also when such unnecessary hardened resin strongly adheres to both of the pot block 9 and the substrate block 5 in the clearance 18, the unnecessary hardened resin is expelled by the thrust bar 26 moving up with large thrust force. Therefore, smooth sliding is further effectively ensured between the lower mold section 1 and the pot block 9 also when unnecessary hardened resin is formed in the clearance 18.

While both of the coil spring 21 and the thrust bar 26 are employed as vertical

moving means in the third embodiment, only the thrust bar 26 may alternatively be employed. In this case, the thrust bar 26 functions as the vertical moving means for vertically moving the pot block 9. In this case, further, the thrust bar 26 preferably presses the pot block 9 against the upper mold section 2 with a proper pressure when the upper and lower mold sections 2 and 1 are closed. Therefore, the resin sealing apparatus preferably comprises a pressure sensor detecting the pressure for pressing the pot block 9 against the upper mold section 2 and control means controlling the vertical movement of the thrust bar 26 in response to the value detected by the pressure sensor.

In the aforementioned resin sealing apparatus according to the third embodiment, the substrate block 5 partially constituting the lower mold section 1 is in contact with the bottom surface of a recess 4 provided in the lower mold section 1. According to the present invention, however, the substrate block 5 may alternatively be integrated with the lower mold section 1.

In the resin sealing apparatus according to the third embodiment, the coil spring 21 is used as an elastic member supporting the pot block 9. Alternatively, the coil spring 21 may be replaced with another type of spring serving as an elastic member. Further alternatively, a metallic material, a composite material containing a metal or a polymeric material may be used as the elastic member so far as the material has prescribed elasticity, durability and heat resistance.

In the resin sealing apparatus according to the third embodiment, the upper mold section 2 moves downward so that the upper and lower mold sections 1 are closed. According to the present invention, however, the resin sealing apparatus may alternatively close the upper and lower mold sections 2 and 1 by moving the lower mold section 1 upward or relatively moving the upper and lower mold sections 2 and 1.

The present invention is also applicable to a resin sealing apparatus setting substrates 16 on both sides of the pot block 9 shown in Figs. 1 and 2, 3 and 4 or 5 and 6 respectively for simultaneously sealing two chip-like elements mounted one by one on the two substrates 16 with resin. According to this resin sealing apparatus, efficiency

of resin sealing steps can be further improved.

Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of the present invention being limited only by the terms of the appended claims.

WHAT IS CLAIMED IS:

1. A resin sealing apparatus comprising:

a lower mold section receiving a substrate mounted with a chip-like element;

a pot block, fitted in said lower mold section to be vertically movable, having a pot portion reserving fluid resin;

a plunger fitted in said pot portion to be vertically movable for extruding said fluid resin;

an upper mold section having a cavity provided oppositely to said lower mold section for storing said chip-like element and a resin passage rendering said pot portion and said cavity communicate with each other,

for sealing said chip-like element with hardened resin formed by said fluid resin injected into and hardened in said cavity, and

further comprising vertical moving means vertically moving said pot block, wherein

said upper mold section and said lower mold section hold said substrate therebetween with a proper pressure while said vertical moving means presses said pot block against said upper mold section when said upper mold section and said lower mold section are closed, and

said vertical moving means moves said pot block upward in contact with said lower mold section when said upper mold section and said lower mold section are released from mold closing.

2. A resin sealing apparatus comprising:

a lower mold section receiving a substrate mounted with a chip-like element;

a pot block, fitted in said lower mold section, having a pot portion reserving fluid resin;

a plunger fitted in said pot portion to be vertically movable for extruding said

fluid resin;

an upper mold section having a cavity provided oppositely to said lower mold section for storing said chip-like element and a resin passage rendering said pot portion and said cavity communicate with each other,

for sealing said chip-like element with hardened resin formed by said fluid resin injected into and hardened in said cavity, and

further comprising a movable member pressing said substrate against the side wall of said pot block before said upper mold section and said lower mold section are completely closed, wherein

said pot block and said lower mold section are relatively vertically movable, and

said fluid resin is injected into said cavity while said substrate is pressed against the side wall of said pot block.

3. A resin sealing method using a resin sealing apparatus comprising a lower mold section receiving a substrate mounted with a chip-like element, a pot block, fitted in said lower mold section to be vertically movable, having a pot portion reserving fluid resin, a plunger fitted in said pot portion to be vertically movable for extruding said fluid resin, an upper mold section having a cavity provided oppositely to said lower mold section for storing said chip-like element and a resin passage rendering said pot portion and said cavity communicate with each other for sealing said chip-like element with hardened resin formed by said fluid resin injected into and hardened in said cavity, said method comprising the steps of:

holding said substrate between said upper mold section and said lower mold section with a proper pressure; and

pressing said pot block against said upper mold section,

for closing said upper section and said lower section through the steps of holding said substrate and pressing said pot block, and

further comprising the steps of:

injecting said fluid resin into said cavity with said plunger;

hardening said fluid resin; and

moving said pot block upward in contact with said lower mold section after said upper mold section and said lower mold section are released from mold closing.

4. A resin sealing method using a resin sealing apparatus comprising a lower mold section receiving a substrate mounted with a chip-like element, a pot block, fitted in said lower mold section to be vertically movable, having a pot portion reserving fluid resin, a plunger fitted in said pot portion to be vertically movable for extruding said fluid resin, an upper mold section having a cavity provided oppositely to said lower mold section for storing said chip-like element and a resin passage rendering said pot portion and said cavity communicate with each other for sealing said chip-like element with hardened resin formed by said fluid resin injected into and hardened in said cavity, said method comprising the steps of:

holding said substrate between said upper mold section and said lower mold section; and

pressing said pot block against said upper mold section,

for closing said upper section and said lower section through the steps of holding said substrate and pressing said pot block, and

further comprising the steps of:

pressing said substrate against the side wall of said pot block before completely closing said upper mold section and said lower mold section;

injecting said fluid resin into said cavity with said plunger while pressing said substrate against the side wall of said pot block;

hardening said fluid resin; and

opening said upper mold section and said lower mold section.